

**African-American Biohistory: Relative rankings in the Health and Human History Project.** TED A. RATHBUN, Anthropology, University of South Carolina, RICHARD STECKEL, Economics, Ohio State University, KEITH CONDON, Biological Sciences, Florida International University and THOMAS A. CRIST, Anthropology, Temple University.

The relative placement of the African-American samples in the History of Health and Nutrition in the Western Hemisphere Project provided both some expected results and some surprises. In the over all health index results, these samples scored in the middle and lower ranges of the scale. Surprisingly, these 19th and 20th century groups excavated from urban and rural contexts had among the best and the worst health scores except for some prehistoric Native American peoples.

Due to small sample sizes in the original data collection, some groups had to be consolidated for meaningful statistical analysis. However, three of the African American skeletal samples discussed here represent intact collections. From the Remeley Plantation near Charleston, S.C., 35 enslaved individuals who died between 1840 and 1870 are included. Urban free African Americans from the Philadelphia First African Baptist Church, of the early 19th century numbered 90, and 1157 burials from the Freedman Cemetery dating from the late 19th century in Dallas, Texas are included.

Although ecological, temporal and biological variables such as prevalence of anemia, infections, enamel hypoplasias, dental disease, and degenerative joint disease were significant for these groups and their relative scores, biocultural features such as occupation and access to food, health and support systems, and physical labor levels provide supportive evidence for interpretation.

**The evolution of anthropoid jaw loading and kinematic patterns.** M.J. RAVOSA, C & M Biology, Northwestern University Medical School, Chicago, IL 60611-3008, Mammals, Field Museum of Natural History, Chicago, IL 60605; S.A. ISLAM, DDS Program, Northwestern University Dental School, Chicago, IL 60611-3008.

Although our knowledge of the functional bases of primate mandibular form is quite considerable, less is known about the phylogenetic and adaptive significance of specific primate jaw loading and kinematic patterns. For instance, while "wishboning" during mastication is the most important determinant of symphyseal form in crown anthropoids, it is unclear *why* this loading regime and underlying jaw movements first evolved in the last common ancestor of platyrrhines and catarrhines. To offer further insight into the evolution of anthropoid wishboning, we provide new metric analyses of suborder

variation in masticatory function and integrate such results with prior data on jaw loading and kinematics.

Ten craniofacial dimensions were obtained for 22 prosimian (n=87) and 36 anthropoid taxa (n=316). A series of correlation, ANOVA and regression analyses were performed within and between the two suborders.

Versus prosimians, anthropoids have relatively deeper crania and thus vertically longer ascending rami. As the position of the zygomatic arches and lateral pterygoid plates does not differ between suborders (in norma frontalis), due to their shorter rami, prosimians evince more transversely oriented masseters and medial pterygoids than like-sized anthropoids. Controlling for size, anthropoids are more isognathic than prosimians. In both suborders, smaller taxa have more transversely oriented adductors and exhibit greater anisognathia.

Due to the late activity of the balancing-side deep masseter, significant lateral transverse bending of the corpora occurs at the end (Phase II) of the masticatory power stroke. Therefore, wishboning may evolve in taxa requiring a greater emphasis on transverse jaw movements during chewing and biting. For example, a larger, and perhaps more mediolateral, component of Phase II molar occlusion is increasingly evident in oligopithecids, parapithecids and propliopithecids. However, prior kinematic work suggests that prosimians and anthropoids exhibit similar chewing orbits and thus evince comparable levels of transverse jaw movement. As crown anthropoids have less advantageously placed masseters and medial pterygoids, we suggest that the jaw-adductor activity pattern underlying wishboning is one solution to this biomechanical problem. In the case of crown anthropoids, it is possible for a balancing-side muscle to effect coordinated movements of the working-side corpus because all such taxa have fused symphyses.

**Real-time visualization of computed tomography datasets in anthropology.** W. RECHEIS, H. SEIDLER, D. ZUR NEDDEN, Dept. of Radiology II, Innsbruck University Hospital, Institute of Human Biology, University of Vienna, Austria.

Modern techniques in image acquisition like computed tomography (CT) and image postprocessing are commonly used in routine clinical diagnosis and operation planning. During the last years these methods have become a valuable tool for non-destructive examinations of endomorphological structures in precious anthropological findings. In most cases, these CT-images are postprocessed for three-dimensional reconstructions and stereolithographic modelling.

In this paper we evaluate a new method: the so-called real time volume rendering workstation. Computed tomography scans are normally taken from the objects in hospitals near the locations where they are stored with the best spatial resolution (e.g.: 1mm slice thickness, optimized zoom factor) and highest grey value dynamics possible. The postprocessing is performed using mostly commercially available soft- and hardware like Silicon Graphics Indigo II and Onyx workstations and biomedical software packages like Analyze (R) or 3dViewnix (R). Our most advanced tool in image processing and visualization is the Real-Time Volume Renderer which uses an Onyx i-Station as the hardware platform. The system allows interactive manipulation and visualization including rotation, cutting, multiplanary reconstruction, dynamic thresholding, coloring,

etc. of CT-volume datasets with 2-10 frames/second („real time“). The preparation of the data volume for the rendering process takes a few seconds. Thresholds and colors of interest can be stored in presets thus accelerating the visualization process. The program offers various measurement possibilities like lengths, angles or volumes. Another feature is the stereoscopic view via shutter glasses giving real spatial impressions of a scene. This system was successfully applied on different anthropological objects: The skulls of Petralona, Broken Hill, Monte Circeo, Steinheim, Le Moustier and especially the Iceman. Though the Real Time Renderer was designed originally for medical purposes it offers a simple, quick and accurate access to morphological structures in anthropological findings that were examined with computed tomography.

**Evolutionary affinities of aboriginal Australian and Papua New Guinean populations: a comparison of mitochondrial, HLA, and Y chromosome genetic data.** A.J. REDD and M. STONEKING, Department of Anthropology, Pennsylvania State University, University Park, PA 16802.

The biological origins of aboriginal Australian and New Guinean populations are enigmatic. Archaeological evidence suggests that humans first entered Sahul, the single landmass joining Australia, New Guinea and Tasmania, at least 60,000 years ago from Southeast Asia. Many anthropologists favor a common origin of Australian and New Guinean populations. However, genetic studies using HLA,  $\alpha$ -globin, or classical polymorphisms have shown a lack of concordance within and between each genetic system with respect to Australian and New Guinean origins and affinities. A previous mitochondrial DNA (mtDNA) study did not show any particular association between Australians and Papua New Guineans (PNG).

To address these issues we examined variation at three genetic systems (mtDNA, HLA class II loci, and Y-chromosome short-tandem-repeat loci) in Australian (Arnhem Land, Sandy Desert), Highland PNG (Southern and Eastern), and East Indonesian (Moluccas and Nusa Tenggara) populations. Based on mtDNA sequence analysis to date, the average sequence divergence within the Australians (1.66%) and the PNG (1.93%) was greater than the average sequence divergence within Indonesia (1.41%). In addition, the net divergence between Australians and Indonesians, and PNG and Indonesians, was smaller than the net divergence between Australians and PNG. These results do not suggest a simple single origin of Sahulians. We will discuss the results of further analyses of these data; the degree of concordance or lack thereof among the mtDNA, HLA, and Y-STR data will be evaluated.

**Fluctuating asymmetry of a-b ridge count and canalization: An appraisal based on Indian population samples of diverse backgrounds.** B.M. REDDY, Laboratory of Biological Anthropology, University of Kansas, Lawrence, KS 66045-2110

**Fluctuating asymmetry in general and particularly the a-b ridge count asymmetry is considered a good**

**measure of developmental homeostasis/canalization. Assuming that the extreme phenotypic values result from poor canalization, hence more asymmetric, than those close to the mean, a quadratic relationship is hypothesized between fluctuating asymmetry taken as the absolute difference between the a-b ridge counts of right and left hands, and the phenotypic value, taken as sum of a-b counts on the two hands. This hypothesis has been tested in few populations and these results are found to be inconsistent, giving good fit in some populations but not in others. Since these samples come from restricted backgrounds and also from a relatively “unstressed” sections, the need for further studies with appropriate data is stressed. In the present study we propose to test this hypothesis using a-b ridge count data on a large number of Indian samples (12 male and 7 female populations) with diverse backgrounds – marine fishermen, inland fishermen, migrants, scheduled tribes and other castes.**

**A multiple regression analysis was performed using fluctuating asymmetry of a-b ridge count as dependent variable and the polynomials of a-b count (up to 2 degree) as independent variables on each of the 19 samples. In only two of the 12 male and one of the 7 female samples a statistically significant ( $p < 0.05$ ) quadratic fit is apparent. On the basis of these results, it is hardly possible to accept the hypothesis concerning the relationship between dermatoglyphic asymmetry and canalization. Nevertheless, our samples also lack representation of castes from the urban and upper strata of the society, as well as from the lower castes.**

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**Leading limb preference during duetting in *Hylobates*.** JOHN C. REDMOND JR., Department of Anthropology, SUNY at Albany, NY 12222.

Most human populations consist of approximately 90% right handers with the remaining 10% either left handed or ambidextrous. However, for nonhuman primates, handedness is far less clear. One reason for the near universality of human handedness may be attributed to its connectivity with language. That is, humans are left hemisphere dominant for language, and Broca's speech area in the left frontal lobe is adjacent to the motor representation for the right hand.

Likewise, while language is largely the domain of the left hemisphere, melodic aspects of music are considered properties of the right hemisphere. Moreover, because hemispheric specializations for speech and handedness usually coincide, one way to access neurological functional lateralization is through behavioral observations of handedness.

However, while language and extreme right handedness exist only with humans, some nonhuman primates such as gibbons produce melodious songs. A large number of studies have looked at handedness

patterns in nonhuman primates, yet, few have focused on the lesser apes (*Hylobates*), which occupy a unique position among apes in relation to humans for this type of study because of their melodious duets and monogamous social structure.

The results of this study examine the lateralized hand use patterns of male and female *hylobates* both while they are silent and during duetting. Video taped frame by frame analysis of individuals are examined to determine leading limb preference during the vocalization phase of duetting. Nonparametric test both within and across subjects utilizing a  $p = .05$  are used to interpret handedness at the individual, sex and population level.

Differences in cortisol levels of anubis and hamadryas baboons captured in the Awash National Park, Ethiopia. P.E. REED, Tufts University School of Veterinary Medicine, Grafton, MA, 01536-1895, J.E. PHILLIPS-CONROY, Washington University School of Medicine, St.Louis, MO 63110, C.J.JOLLY, New York University, NY 10003, and S. K. WASSER, University of Washington School of Medicine & Center for Wildlife Conservation, Seattle, WA 98195.

Prior work has shown variation in serum testosterone (Phillips-Conroy et al.1992) and csf-serotonin levels (Fontenot et al. 1997) in baboons of the anubis-hamadryas hybrid zone which may reflect differences in social organization and mating systems. Here, we report the results of analysis of fecal samples collected during the summer of 1997 when anubis, hybrid and hamadryas baboon groups were captured. Fecal samples were collected in pure ethanol at the time of capture. Cortisol was extracted from feces upon return to the United States. 0.2g lyophilized feces were boiled (20 min) in 90% ethanol (10ml) and centrifuged (15 min at 1500 g). The supernatant was removed, dried, and reconstituted in 1 ml of methanol, which had been diluted in PBS buffer prior to assaying with an ICN 1-125 corticosterone kit. Using dental eruption and occlusal wear standards developed previously (Phillips-Conroy & Jolly 1988), we assigned ages to all animals; subadults were under 100 months of age and adults were over 100 months.

Mean values of cortisol (ng/g feces) were 30.8 for anubis subadult males (n=5), 45.0 for anubis adult males (n=9), 43.6 for anubis female subadults (n=7), 61.8 for anubis female adults (n= 3), 60.8 for hamadryas male subadults(n= 12) and 82.1 for hamadryas male adults (n=12). The value for the single hamadryas subadult female was 48.0 ng/g. The regression of cortisol on age was significant for anubis males ( $p=.028$ ), but not for anubis females ( $p=.176$ ) or hamadryas males ( $p=.135$ ). The difference between anubis and hamadryas subadult males was not statistically significant ( $p=.105$ ) in contrast to the difference between anubis and hamadryas adult males ( $p=.002$ ).

The overall higher cortisol values observed in hamadryas males suggest that pre-baiting was a comparatively stronger stressor for these animals. We provisionally advance two reasons for this: first, since the hamadryas baboons had not been previously captured, the novelty of events surrounding capture compounded the stress of feeding competition. Second, harem-holding males potentially imperiled their ownership of females by competing with other males for bait. Finally, the differences in cortisol values between subadult and adult anubis males may reflect different developmental stressors in the life of anubis males compared to hamadryas males.

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A dynamic modeling approach to the study of callitrichine life history, demography, and social systems. J.A. REHG, Department of Anthropology, University of Illinois, Urbana, IL 61801.

The size and composition of primate groups are affected by many factors, including litter size, interbirth interval, mating and breeding systems, migration patterns, predation, and life span. Tamarins and marmosets possess high individual reproductive potential: females exhibit postpartum estrus and may have as many as two litters of twins each year. In most species that have been studied, however, there is evidence that generally only a single female in each group breeds. The purposes of this study are to investigate the applicability of computer models for studying callitrichine social systems, and to examine how callitrichine migration patterns, breeding systems, and life history characteristics influence the size and structure of social groups.

The computer modeling program, STELLAH, was used to create a dynamic spatial simulation of populations of a generalized tamarin and a generalized marmoset species. Groups were subdivided into different age and sex classes. Factors affecting the composition and size of each group, including initial group size, birth rate, predation rate, and migration patterns were included. Values for these parameters were based on published data from studies of captive and wild callitrichine species, such as *Saguinus fuscicollis*, *S. mystax*, *Callithrix jacchus*, and *C. flaviceps*.

Based on published data, the simulations of the model support predictions that differences in marmoset and tamarin rates of reproduction and migration patterns affect group structure. In the absence of migration, tamarin and marmoset groups stabilize at different average sizes, but at similar mortality rates of 20-35%. However, given observed levels of emigration in tamarins (net dispersal of 5% in some species) and marmosets (as much as 17%), neither can suffer mortality losses greater than 20% without the potential for population crashes. In addition, attributing disappearances of unknown cause to emigration versus death may result in as much as a 20 fold increase in callitrichine population sizes after a 100 year period. Additional issues related to social organization and demographics in callitrichines are discussed.

Population genetics and models of modern human origins. J.H. RELETHFORD, State University of New York College at Oneonta, Oneonta, NY 13820

Genetic data have increasingly been used for addressing models of the origin of modern humans, most notably the African replacement model and the multiregional evolution model. Both classic population genetics models and coalescent theory have been used to interpret patterns of genetic variation within and among human populations. Many of the studies to date have explicitly used phylogenetic models that assume human prehistory can best be explained by successive fissioning of populations. More recently there has been increased emphasis on a population

structure approach, looking at the possible influence of variation in population size and migration rates.

A major problem with many analyses to date is that the results are often indeterminate, such that there may be reasonable alternative interpretations. For example, the higher level of within-group diversity seen in sub-Saharan African populations has often been interpreted in terms of the African replacement model, where diversity is taken to be proportional to time. However, increased diversity can also be interpreted in terms of larger African population size, which in turn can fit a variety of origin models. Genetic distances between human populations provide another example; the pattern of among-group distances can be a reflection of either of phylogenetic branching or variation in migration rates, the latter of which can fit several different origin models. To date, the strongest evidence in favor of an African replacement model is the finding of low long-term effective species size, but even here there are other possible alternatives. This paper further describes some new approaches for extending population genetic models to analysis of the fossil record through computer simulation of temporal distances and of regional continuity. Once again, observed patterns of variation can fit both African replacement and multiregional models.

An integrative Approach to Hominoid Forelimb Elongation. P.L. RENO, C.O. LOVEJOY, and R.S. MEINDL. Department of Anthropology, Kent State University, Kent, OH 44242. M.A. McCOLLUM, Departments of Anatomy and Oral and Maxillofacial Surgery, Case Western Reserve University, Cleveland OH 44106.

The lengths of long bones and their relative contributions to overall limb length are clearly major foci of adaptation in primates. Potentially, there are three means by which long bone length may be altered by selection: 1) the size of the anlagen may be changed, 2) the overall duration/rate of growth of the entire limb skeleton may be changed by systemic mechanisms, and 3) the duration/rate of local mitosis in the growth plate may be changed. Each of these very probably involves a different genetic pathway. While the ideal means of investigating these kinds of adaptations would be a combination of embryological and longitudinal growth data, such data may be virtually impossible to obtain for most species. However, it may nevertheless be possible to discriminate from among these three mechanisms by using appropriately designed studies of adult long bone metrics. Such methods could then be extended to the fossil record.

This present study examines upper limb elongation in extant hominoids. For purposes of analysis the upper limb was divided into seven individual segments. Five of these segments (humerus, distal radius, metacarpal, proximal and intermediate phalanges) possess unrestrained growth plates, the remaining two (radial neck, capitate) do not. In addition to length, the relative positions of nutrient foramina were examined with respect to body mass in order to investigate the contributions of the three potential mechanisms of elongation described above. Results demonstrate that

whereas radial neck length and capitate length scale with body mass across taxa, all remaining limb segments vary with the more arboreal species displaying the greatest amount of individual limb segment elongation. Our results suggest that long bone elongation in the hominoid forelimb takes place almost entirely in the growth plate. Our data also show that alterations of forelimb growth plate programming may be systematic; i.e., pattern alterations are shared by most distal growth sites.

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Simulations of interobserver error within Howells' data set. M.L. RHOADS, Department of Anthropology, University of New Mexico, 87131.

Many researchers in physical anthropology use the widely available Howells' data set in order to enlarge their own data sets. Many of the researchers then perform statistical tests upon these combined data sets. A poster presentation by Ozolins et al. (1997) at the American Association of Physical Anthropologists meetings used Howells' data set to compare Pleistocene fossil hominids with modern humans. Concerns of the researchers and the readers of the poster lead to speculation that the lack of interobserver error in Howells' data set could affect the results reached by Ozolins et al. This study tests whether the lack of interobserver error in Howells' data set can affect the results obtained by researchers using multiple data sets.

To test the effects of interobserver error, the eleven craniometric measurements used by Ozolins et al. are randomly assigned "error" for each of the individuals in Howells' data set. Differences between the original and the "new" data sets are then tested. Since principal components were computed in the Ozolins et al. study, principal components are computed on the "new" data sets derived through the randomization of "error" in the present study. A significant difference is found between the principal components from the original Howells' data set and the "new" data sets constructed to simulate the interobserver error. Distances between the original Howells' data set and the new Howells' data sets are computed to substantiate and quantify the differences observed between the data sets.

Longitudinal Study of Anterior Cranial Base Length in African American Males with a Comparison with European American Males.

RICHARDSON, E.R. and MALHOTRA, S. K., Meharry Medical College, Nashville, TN, USA

The anterior cranial base of Blacks is usually described as being much shorter than is

seen in Whites. These observations have been made on persons of orthodontic treatment age.

The objectives of this study were to make observations on the growth in length of the anterior cranial base of Black males, and then compare it longitudinally with that of White males. We hypothesize a difference in the relative lengths of the anterior cranial base in two ethnic groups based on age.

**Materials & Methods:** Lateral cephalograms were available on 41 Black males ages 6 to 16. They were from Nashville, TN. The sella-nasion distance was measured and corrected for enlargement. Comparable data were available on two samples of White males (from Ann Arbor and Cleveland). The t test was used to test for differences.

**Results:** The sella-nasion distance in Black males was 64.3mm with a standard deviation of 3mm at age 6. The S-N distance continued to increase approximately 1mm per year until age 10 or 11, after which, the increase continued, but at a slower rate.

In comparison with White males, the difference in the S-N distance was not statistically significant up to age 10. The S-N distance became larger in the White male by age 11. The difference being statistically significant. The S-N distance in the White male continued to increase relatively uniformly from age 6 to 16.

**Conclusions:** The difference in the length of the anterior cranial base (S-N) in Blacks and Whites is not statistically significant up to age 10. This is significant since brain growth is essentially complete by age 8 or 9. The S-N distance continues to increase at a more rapid rate in White males than in Black males, from age 10 to 16. This is important to persons interested in facial profiles.

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Finite element models of manual proximal phalanges in three modes of locomotion. B.G. RICHMOND, Dept. Anthropology MRC112, Smithsonian Institution, Washington, D.C., 20560.

The form and function of the hand are central themes in many studies of primate and human evolution. The skeletal design of the hand is thought to be closely linked to locomotor mechanics, manipulatory capabilities, and substrate use. This study investigates hand kinematics (posture) and kinetics (pressure), and uses finite element analysis (FEA) to better understand phalangeal function and biomechanics in three modes of locomotion: suspension, and arboreal and terrestrial quadrupedalism.

Kinetic data were collected on various substrates for *Hylobates lar*, *Macaca fascicularis*, and *Erythrocebus patas* using a 16x16cm capacitance-sensor pressure pad (Novel). Experiments were simultaneously videotaped, including frontal, lateral, and palmar views, from which kinematic data were collected. 2-D isotropic FE models were created and analyzed using ALGOR.

Hand postures differ dramatically in the three modes of locomotion, leading to differences in phalangeal mechanics. Suspension is characterized by high flexion angles at the

mp (metacarpo-phalangeal) and ip (inter-phalangeal) joints. In arboreal quadrupalism, the joints are only slightly flexed. In both, the entire ray applies pressure to the substrate. The terrestrial quadruped contacts the substrate with its metacarpal head and distal phalanx, but not with its proximal and middle phalanges. Instead, the mp joint is extended and the pip (proximal inter-phalangeal) joint is flexed, holding the pip joint above the ground and providing better leverage for the flexor tendons.

FEAs indicate that, in all three modes, the proximal phalanges experience predominately dorsoventral bending (dorsally concave). However, bending stresses are lower, and longitudinal compression higher, in the quadrupedal models. The larger bending stresses in the highly-flexed grasping posture may be responsible for the greater shaft curvature observed in suspensory primates.

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#### Subadult Growth in an Ancient Nubian Population: A Population-Specific Analysis.

JS RICHTSMEIER and DP VAN GERVEN, Department of Anthropology, University of Colorado, Boulder, CO 80309

The present study compares rates of subadult attainment of adult tibial length between two Christian cemeteries from the medieval (550-750) site of Kulubnarti in Sudanese Nubia. The method derives from Mensforth (1985) and is based on the computation of subadult lengths as a percentage of adult average diaphyseal length for each cemetery sample.

Previous research on the subadult remains has demonstrated a consistent difference in childhood stress between the two Kulubnarti cemetery samples. Cemetery 21-S-46, located on a small island adjacent to the west bank of the Nile, has been associated with architectural features indicative of considerable impoverishment. In contrast, cemetery 21-R-2 represents a community living under substantially more comfortable circumstances. Subadults from the 21-S-46 site have revealed higher infant mortality, increased frequencies of cribra orbitalia, dental hypoplasias, growth arrest lines, and developmental retardation. The present investigation assessed growth differences between these economically distinct groups based on population-specific standards of adult size and thus avoided recourse to external (modern) growth standards. Furthermore, by converting the growth data to polynomial regressions, differences in age-specific sample sizes was avoided.

A polynomial comparison of absolute length between the two cemeteries (21-S-46 n = 99, 21-R-2 n = 49) revealed a consistent difference. Across all age categories from birth through 15 years the 21-S-46 sample had smaller tibiae. This difference was repeated when lengths were converted to proportions of the adult average for each group.

A further comparison between children with and without cribra orbitalia was conducted on the combined samples to determine whether dietary factors may have contributed to growth differences. The results indicate that while children with the lesion begin life larger than their non-anemic counterparts, their rate of growth

declines consistently and falls below the non anemic children by age six. This decline continues through the oldest (15-year) age category.

Respiratory infection in the individuals from the post-Medieval crypt at Spitalfields, London: a biocultural approach. C.A.ROBERTS, Calvin Wells Laboratory, Department of Archaeological Sciences, University of Bradford, BD7 1DP, U.K.

Research during the 1980s and 1990s have suggested a link between proliferative new bone on visceral rib surfaces and inside maxillary sinuses which may be indicative of lower and upper respiratory infection, respectively (eg. Micozzi and Kelley, 1984; Lewis et al., 1995). The current general consensus is that the lesions are non-specific in nature, despite suggestions that those on the ribs are most likely to be tuberculous in origin.

This study explores this work further and concentrates on a post-Medieval cemetery population from Spitalfields, London, testing the hypothesis that living conditions in the city at the time that the crypt was in use would have predisposed the population to infections of the respiratory tract. All available visceral rib surfaces and maxillary sinuses were examined for evidence of pitting and/or new bone formation; in addition, the spine, hip and knee joints were also examined for evidence of tuberculous bone change. Problems with access to intact maxillary sinuses and survival of ribs and sinuses are discussed.

Initial analysis of the results show a lower frequency of non-specific infection in those anatomical areas than was expected. Age and sex differences in frequency were also explored. Correlation of the historical data associated with this population allowed a biocultural approach to the study.

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Palaeopathology and the Treatment of the Poor in an 18th and 19th Century Infirmary  
D. J. ROBERTSON and H. V. START (ARCUS, University of Sheffield, South Yorkshire. UK)

Osteological analysis of remains from Newcastle Infirmary Burial Ground (1753-1845), has provided a unique opportunity to examine a skeletal sample displaying early evidence of surgery. This paper presents new interpretations of the treatment, both medically and socially, of the impoverished, using primary skeletal evidence to challenge and support surviving contemporary documents.

Medical treatment was not open to all, and rules were set to restrict access to individuals of a working age with no infectious diseases. Palaeodemographic profiles correlate closely with the burial register. However, there is abundant evidence for infectious

disease such as tuberculosis and syphilis. Over one-hundred limb amputations and several trepanations provide direct evidence of surgical procedures performed during a period where surgery was evolving into a modern discipline.

Treatment was only one aspect of the Infirmarys function. The poor were also used directly for the development of surgical techniques and to train apprentice surgeons. This was practised not only on the living, but also the dead, illustrated by the occurrence of multiple amputations on limbs.

The analysis of these remains provides direct evidence for certain surgical procedures on a section of society that is rarely studied or thought to be of academic worth. These attitudes are misplaced, as the remains have made a positive contribution to medical history and medical anthropology. They represent advances in a period which sees the emergence of medicine and surgery as separate modern disciplines.

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A Comparison of the Temporal Bone of Aboriginal Australians with that of other Modern Human Populations. R.M.ROBINSON, University of Melbourne, Victoria, 3052, Australia, and L.C.AIELLO, University College London, London, WC1E 6BT, U.K.

The morphology of the temporal bone of East Asian *H. erectus* is regarded as uniquely distinctive. If there has been regional continuity between modern Aboriginal Australians and archaic *H. sapiens* in S.E.Asia, it would be reasonable to expect that temporal bone characteristics would be among the continuity traits, and that the temporal bone of Aboriginal Australians would be remarkably different from that of other modern human populations.

To assess the distinctiveness of the Aboriginal Australian temporal bone, a cranial sample representing 6 regionally distinct modern human populations was investigated. Univariate and multivariate analyses of temporal bone data from the sample show that on the basis of temporal bone variation alone not only Australians but all the populations can be discriminated.

A different combination of temporal bone characteristics for each population describes the temporal bone typical of that population. The Australian temporal bone is characterised by a long, transversely deep and acutely angled mastoid process, a low temporal squamous, a tympanic plate with thick lateral rim and a wide, long glenoid fossa. However, in no single temporal bone feature are Aboriginal Australians found to be remarkably different from all other modern human populations.

Similarities and differences in temporal bone morphology further suggest possible affinities between specific populations. The Australian temporal bone is

most dissimilar to that of Chinese and most similar to that of Africans, whereas the Chinese temporal bone is least distinguishable from that of Europeans.

The pattern of temporal bone variation among modern human populations offers no evidence to support the existence of continuity in the Australian-S.E. Asian region.

Morphology of the drifting osteon. A G. ROBLING and S.D. STOUT, Department of Anthropology, University of Missouri, Columbia MO 65211.

Since their formal description in the early 1960s, drifting osteons have received little attention in histologic studies of bone remodeling. Drifting osteons are formed by resorption and formation fronts that simultaneously proceed axially and transversely through the cortex. This action produces hemicyclic deposition of lamellae, ultimately resulting in an osteon that appears to "drift" transversely through the cortex. The formation process in drifting osteons contrasts with that characterizing other subtypes of secondary osteons (e.g., type I, type II, zonal), where resorption proceeds axially, and lamellae are deposited concentrically.

The three-dimensional structure of drifting osteons is not well understood and consequently is not considered in theories addressing their functional significance. To this end, we undertook a study of drifting osteons from human and baboon long bones. Their 2- and 3-dimensional morphology was examined in several sets of serial sections cut from lower limb bone diaphyses. Viewed individually in 2-D cross sections, we observed that the majority of drifting osteons are directed toward the endosteum, but the transverse course of drift can change, in some cases by more than 360°. The latter observation is evidenced by the trail of hemicyclic lamellae that records the direction of transverse drift in single sections.

When drifting osteons were followed longitudinally through sets of adjacent sections, we observed that 1) the direction of transverse drift within the same system can be toward the periosteum at one cross-sectional level and toward the endosteum (180° different) at another cross-sectional level only a few hundred micrometers proximal or distal, and 2) the same system can be drifting at one cross-sectional level and nondrifting (concentric deposition) at another.

Existing literature on drifting osteons emphasizes a biomechanical explanation of their production and "steering" (Epker & Frost 1965), however, the results of this study are not accurately explained by current concepts of strain-induced bone remodeling. Alternate explanations for drifting osteon formation are discussed.

High altitude inhibits stimulation of uterine artery growth during pregnancy. LC ROCKWELL, M White, LE Keyes, S Zamudio, and LG Moore. University of Colorado Health Sciences Center and Denver Campus, Denver, CO 80262.

Profound vascular changes occur during pregnancy, entailing a doubling of uterine artery diameter and

remodeling of the uteroplacental circulation. High altitude may interfere with these changes as judged by smaller uterine artery diameter and reduced blood flow in women residing at high vs low altitude in Colorado. We hypothesize that chronic hypoxia interferes with the stimulatory effects of pregnancy on vascular growth in the uteroplacental circulation.

To determine the effects of pregnancy and chronic hypoxia on vascular proliferation *in vivo* and *in vitro*, we used a guinea pig animal model with significant human parallels. Non-pregnant or pregnant animals were studied at low (n = 19, 1600 m) or high (n=38, 3962 m) altitude. BrdU (bromodeoxyuridine, a thymidine analog) immunohistochemistry was used to measure the % cells undergoing replication in uterine, radial and non-uterine vessels *in vivo*. Smooth muscle cells were cultured from the uterine artery to assess vascular proliferation *in vitro*.

Pregnancy increased uterine artery diameter by stimulating vascular proliferation at both altitudes. At low altitude peak replication indices in the uterine artery occurred at mid-pregnancy. The increase over non-pregnant values was 14-fold in the intima, 41-fold in the media and 4-fold in the adventitia. High-altitude reduced the mid-pregnancy maximum replication indices by 35%, 76% and 70% in the respective vessel layers. Peak proliferation occurred in the radial artery near term at low altitude. The rise over non-pregnant values was 4-fold in the intima, 17-fold in the media and 12-fold in the adventitia. At high altitude the maximum replication index occurred earlier and the maximum replication indices were reduced by 50%, 25% and 63% respectively. At both altitudes cultured cells from animals studied at mid-pregnancy (42 days) have enhanced proliferative response. In cells from hypoxic animals, however, the magnitude of the response is diminished and the maximum cell number is achieved more slowly.

Chronic hypoxia inhibits the stimulatory effects of pregnancy on vascular growth in the uteroplacental circulation. Furthermore, the effects are present at a cellular level. Such factors may exhibit evolutionary variation as suggested by the lesser IUGR and possibly higher uterine artery blood flow in Tibetans compared with other high-altitude residents. (NIH 14985, NIH Training grant HL 07171-21)

Bayesian inference about ancient population sizes. A.R. ROGERS, Dept. of Anthropology, University of Utah, Salt Lake City, UT 84112

In statistical inference, it seems natural that one should be interested in the probability that one's hypothesis is true, given the data: say  $\Pr(H|D)$ . Yet this approach is preferred only by a minority of statisticians, the so-called Bayesians. Conventional statistics does it the other way around: it studies  $\Pr(D|H)$ . This reflects in part the difficulty of performing the Bayesian calculation. Today, faster computers and better algorithms are making Bayesian calculations practical, and Bayesian statistics are entering the main stream.

The algorithm that has done most to facilitate Bayesian inference is Markov Chain Monte Carlo integration. I use this method here to infer the history of a population's size from genetic data. In each run, the computer program prints many thousands of values of the parameters describing population history. These provide an estimate of the posterior probability distribution of the parameters given the data.

With mitochondrial genetic data, the resulting estimates are consistent with those of mismatch analysis but are more precise. The method provides a powerful test of the hypothesis of constant population size. This hypothesis is rejected unambiguously even with data for which mismatch analysis provides no information.

A genetic linkage map of the baboon (*Papio hamadryas*) genome with 10 cM resolution.

J. ROGERS<sup>1</sup>, P.A. MORIN<sup>2</sup>, M.C. MAHANEY<sup>1</sup>, and S. WEDEL<sup>2</sup> <sup>1</sup>Dept. of Genetics, Southwest Foundation for Biomed. Res., San Antonio, TX 78245

<sup>2</sup>Sequana Therapeutics, Inc, La Jolla CA 92037

We are developing a genetic linkage map of the baboon genome, using microsatellite loci already mapped in the human genome. Genotypes for microsatellites are determined for a multi-generation pedigree of 690 baboons maintained at SFBR. At present, our baboon map consists of 297 polymorphic loci. These genetic markers are distributed over all the autosomes and the X-chromosome. The microsatellites are analyzed in baboons using human PCR primers. The average number of alleles per locus is 9.8. Average heterozygosity is 0.75. For 253 of these loci, multipoint linkage analysis produces a single mapping order 1000 times more likely than any other order. The remaining 44 loci are mapped to regions within chromosomes, but do not show one definitive order. The average spacing among the 253 definitively mapped loci is 10.3 centiMorgans. This density of markers is sufficient for comparative analyses of chromosome evolution, and for linkage mapping studies intended to locate unknown functional genes that influence phenotypes of interest, such as genes that affect risk for diseases or influence normal phenotypic variation.

The order among loci on baboon chromosomes shows the two genomes differ by inversions on human chromosomes 1, 4, 6 and 11. Other differences that were predicted by karyotype studies have also been confirmed using linkage, e.g. that human chromosome 2 is divided in baboons. This map provides the basis for studies of comparative genome evolution and for gene mapping studies designed to locate functional genes of evolutionary interest.

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Selecting a calibration method to reduce bias in histological aging methods. N.L. ROGERS, University of Tennessee, Knoxville, 37996, S.D. STOUT, University of Missouri, Columbia, 65211.

In 1996 the Stout and Paine (1992) formula for age estimation from the clavicle was tested using a historic

Swiss cemetery sample of known age (Stout et al., AJPA). The resulting age estimates were systematically biased toward the mean of the modern reference sample. This result was correctly attributed to the different age distributions of the two samples, and a predictive formula based upon a combined sample was generated to offset this result. In this study we offer an alternative method of calibration as an additional answer to this problem of bias and provide guidelines for choosing a method of calibration that provides a compromise between bias and efficiency of the estimate.

This study builds upon previous discussions of inverse calibration, the regression that models age as dependent upon the histological variable, and classical calibration, which models the histological variable as dependent upon age. The characteristics of each method of calibration have been shown to affect the age estimates generated by their predictive equations.

Inverse and classical predictive formulae were derived using histological rib data from a subset of the Stout and Paine autopsy sample. Both equations were then tested on rib data from the Swiss cemetery sample. Results for the inverse equation mirrored those from the 1996 clavicle study, with the age estimates systematically biased toward the mean of the autopsy sample and a root mean squared error value (RMSE) of 8.00 years. The classical equation produced relatively unbiased age estimates and an RMSE value of only 3.76 years.

In this case we suggest a classical calibration formula be used since it provides less biased age estimates when the age distributions for the target sample differs from the reference sample. However, this is not necessarily the case for all situations. We will present considerations for choosing the method of calibration when generating and applying predictive formulae in other cases of calibration.

Health and nutrition in the western hemisphere: an introduction. J.C. ROSE, Anthropology, University of Arkansas. AR 72701.

At the 1988 Economic History Association meetings Steckel and Rose lamented the communication problems which prevent historians, economists, and biological anthropologists from working together despite common research interests. The ideas planted then were nurtured by a series of meetings held over four years which combined the ideas of numerous historians, economists, and biological anthropologists, ultimately producing the health and nutrition in the western hemisphere project presented in this symposium.

Defining and refining the measurement of living standards have been enduring concerns for economists, while bioarcheologists have tried to measure a population's ability to maintain adaptive equilibrium using skeletal indicators of diet, disease, and stress. Each of these disciplines have long recognized the importance of the quality of life as a force stimulating economic and cultural change. The project combined these diverse methodologies to produce an index of relative biological standard of living.



Participants developed a uniform data recording protocol which enabled 16 bioarcheologists to contribute data on 12,500 skeletons from 65 archeological sites, which were analyzed and interpreted by teams composed of the 35 participating economists, historians, and biological anthropologists using compatible theoretical and methodological frameworks. These efforts have been applied to interpreting the history of health and nutrition of the Americas from 4,000 B.C.E. to the Twentieth Century. This includes their Native American, African American, and European American inhabitants with a geographic range extending from the Andes to Canada. A small group of the participants will here present their analytical results on nineteenth century African and European Americans and the much longer history of Native Americans from South, Central, and North America. These regional studies are preceded by a discussion of the health index and paleodemographic methods.

Sexual dimorphism: transitions between hunter-gatherer, agricultural, and contemporary societies. A.H. ROSS and L.E. FLOURNOY, Dept. of Anthropology, Univ. of Tenn., Knoxville, TN 37996.

Numerous researchers have examined skeletal changes that occur with the transition from hunter-gatherer to agricultural societies. It has been a common tenet that hunter-gatherers have more strenuous subsistence activities than agriculturists. Therefore, greater sexual dimorphism would be expected in hunter-gatherer societies. These previous studies have generally focused on lower limb bones; however, upper limb bones are also reliable predictors of life practices. The objective of this paper is to present a comparative analysis of three samples: an Archaic (females n=36; males n=20), a Late Mississippian (females n=24; males n=15), and a modern forensic sample (females n=48; males n=104).

Measurements were taken for left and right ulnae (max. length, dorso-volar, transverse diameters) and radii (max. length, sagittal, transverse diameters) when obtainable. Means and standard deviations were calculated by sex for each sample. A multivariate analysis of covariance (MANCOVA) was conducted to test the overall heterogeneity and to determine whether overall differences in group means are present. MANCOVA was selected over separate univariate tests because it provides an overall test. MANCOVA assumes multivariate normality and homogeneity of within-group variance-covariance matrices. Wilk's lambda statistic was used to test each effect (population, sex, and population-by-sex interaction). The overall hypothesis test for population-by-sex interaction is significant ( $\text{PrF} > 0.0064$ ). The MANCOVA procedure yielded a significant sex effect ( $\text{PrF} > 0.0001$ ), however, the overall population effect is not significant ( $\text{PrF} > 0.5924$ ). These results suggest that sexual dimorphism of upper limb bones is significantly different between populations.

Clues to recognition of kidney disease in archeologic record. C. ROTHSCCHILD, B.M. ROTHSCCHILD, Arthritis Center of Northeast Ohio, Youngstown, OH 44512, I. HERSHKOVITZ, Anatomy/Anthropology, Sackler Faculty of Medicine, Tel Aviv University, 69978, Israel.

One major disease impacting life occurs when kidneys stop functioning properly. Given the infrequent preservation of visceral soft tissues in the archeologic record, it was of interest to evaluate skeletal markers of disease. Complete skeletons of 94 individuals from the Hamman-Todd Collection, diagnosed during life with chronic renal disease (crd), are examined macroscopically and radiologically to identify potential osseous markers for chronic kidney disease. A sample without renal disease is selected as comparison control.

Subtle macroscopic resorptive changes are present in 19% and porosity in 17% with crd, but no subperiosteal resorption and only 8% porosity in the control sample. Joint surface calcium deposits are present in 80% and crumbling changes in 30%, compatible with diagnosis of calcium pyrophosphate deposition disease (CPPD). This contrasts with 10% of controls. Periosteal reaction is present in 76% of individuals with crd. Average number of affected bone groups among individuals with periosteal reaction is present in 76% of individuals with crd. Tibial involvement (65%) is often unilateral (43%), with common pelvic (24%) and hand/foot (11%) involvement, in contrast to the tibia-predominant (100%) hand/foot/pelvis-sparing syphilis pattern noted in 6% of controls.

While macroscopic periosteal reaction is common in crd, the frequency of calcific joint changes (CPPD) allows recognition of renal etiology, even if the subperiosteal resorption (apparently specific for the hyperparathyroidism of renal disease) is not present. The pattern of joint surface alteration and periosteal reaction may facilitate recognition of chronic renal disease in the osseous record.

Body mass estimation in Olympic athletes and Pleistocene *Homo*. C.B. RUFF, Dept. Cell Biology and Anatomy, Johns Hopkins Univ. Sch. Med., Baltimore, MD 21205, E. TRINKAUS, Dept. Anthropology, Washington Univ., St. Louis, MO 63130, and T.W. HOLLIDAY, Dept. Sociology and Anthropology, Univ. Central Florida, Orlando, FL 32816-1360.

We have previously used anthropometric data from living human populations to develop equations for estimating body mass from stature and bi-iliac (maximum pelvic) breadth in earlier *Homo*. Because it is very likely that Pleistocene *Homo* were on average more physically fit than most modern humans, it is possible that these equations significantly underestimate body mass in such specimens, due to their greater muscularity. To further explore this possibility, we investigated these relationships in Olympic caliper athletes, using anthropometric data collected by Tanner for males participating in the 1960 Olympic Games, supplemented by similar data collected by de Garay for both males and females of the 1968 Olympics.

On average, the equations developed from the world-wide "normal" sample underestimated body mass in male Olympic athletes, but only by an average of about 2 to 4 percent. Our equations actually overestimated body mass to about the same degree in female athletes, possibly due in part to the relatively young age of many of the females. As would be expected, results varied greatly between different types of events. For participants in "weight" events (e.g., shot put, weightlifting), body mass underestimates were greater (7-18%), while for those in long distance running and walking events body mass was overestimated (7-12%). For events combining both strength and speed - decathlon, pentathlon, wrestling - body mass was slightly underestimated in males (4-7%) and slightly overestimated in females (7%). The anthropometric variables that best explained deviations between predicted and actual body mass were the ratio of biacromial to bi-iliac breadth, and muscular size (measured by Tanner from radiographs) relative to body mass or skeletal frame size. Interestingly, variation in relative bone breadth (diaphyseal periosteal diameter, also measured radiographically) was not strongly related to variation in either of these variables, or to body breadths relative to stature, suggesting that greater skeletal robusticity is not necessarily associated with differences in muscular bulkiness or general body build.

These results suggest that any underestimation of body mass in Pleistocene *Homo* from measurements of skeletal frame size, using living humans as a reference sample, may be small, if modern peak athletes can be used as a guide. In addition, they suggest that increased skeletal robusticity may be achieved without a corresponding increase in body or muscle mass relative to skeletal frame size.

Patterns of sexual dimorphism in platyrrhine limb bone diaphyses. J.A. RUNESTAD, Western Illinois University, Macomb, IL 61455, and K.E. GLANDER, Duke University, Durham, NC 27710.

This study addresses the question of whether the males of sexually dimorphic platyrrhine species have limb bone diaphyseal properties that are simply larger than those of females, or whether the properties also differ proportionally from those of females.

Humeral and femoral properties examined include bone lengths and diaphyseal cross-sectional properties. The sample includes several species of sexually dimorphic and nondimorphic platyrrhines. In addition, data for juveniles and subadults of dimorphic ateline species were examined.

Results for sexually dimorphic species indicate that adult males have greater humeral cross-sectional properties relative to femoral cross-sectional properties and relative to humeral length than do females. Humeral length relative to femoral length does not differ, nor do femoral cross-sectional properties relative to femoral length. The males and females of nondimorphic species do not differ. LOWESS charts of ateline age-graded data

augment patterns suggested by the ANCOVA analysis of adults.

These results indicate that the males of dimorphic platyrrhines have humeral diaphyses that are greater in rigidity than expected relative to bone length and femoral rigidity, using females as a baseline. Males of nondimorphic taxa, such as *Ateles*, do not show this pattern.

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Dental attrition and disease in several Pacific Ocean Island populations - Jomonese, Ainu, Maori and Aleut. R.SAKASHITA, Dept. of Preventive Dentistry, Kagoshima University, Japan, N. INOUE, University of Tokyo, Japan (retired), T. KAMEGAI, Dept of Orthodontics, Iwate Medical College, Japan, and D.R. HUNT, NMNH, Smithsonian Institution, Washington D.C.

This investigation examines several Pacific Ocean Island populations: Jomonese, Ainu, Maori and Aleut. Resulting frequencies of dental disease and attrition indicate interesting similarities and divergences between these marine-based subsistence populations.

Samples analyzed in this study consisted of 114 Jomonese (Honshu, Japan, 1000-200 B.C.) and 140 Ainu (Hokkaido, Japan, 19c) housed at University Museum, The University of Tokyo, Japan; 263 Maori (New Zealand, 16-18c) at Otago University, New Zealand; and 144 Aleut (Aleutian, 14-18c) at the National Museum of Natural History, U.S.A. Dental caries, tooth loss, periodontitis and attrition were examined following previously published criteria (Inoue et al., 1982). The teeth with pulp exposure due to attrition, carious teeth, and teeth associated with severe alveolar bone resorption from periodontitis were identified as high risk teeth.

Caries rates were relatively low; 11.0% for Jomonese, 5.5% for Ainu and 2.1% for Maori. The Aleut sample had only two light carious teeth out a total of 1798 teeth (0.1%). Both caries were on the occlusal surfaces of newly erupted M3 teeth. These caries would have been quickly lost by rapid attrition common to this population. Attrition varied, being severe in some groups. Frequencies of teeth worn to the pulp chamber were; 35.2% for Jomonese, 23.2%, Ainu, 43.0%, Maori and 50.8% for Aleut. High risk teeth frequencies for attrition, caries and periodontitis are listed respectively: Jomonese (1.5%, 44.7%, 54.3%), Ainu (1.8%, 18.2%, 80.0%), Maori (45.5%, 14.5%, 40.0%) and Aleut (83.3%, 0.0%, 16.7%). The above results indicate all these marine-based island populations had low incidence of caries but most suffered from moderately high or severe dental attrition. This would be a result of the high protein, high grit diet of these populations. High risk factor frequencies in the Jomonese and Ainu from caries and periodontitis would most likely be associated to cultural food processing by these populations while masticatory hide and food processing by Maori and Aleut caused their high attrition risk factor.